Problem 1
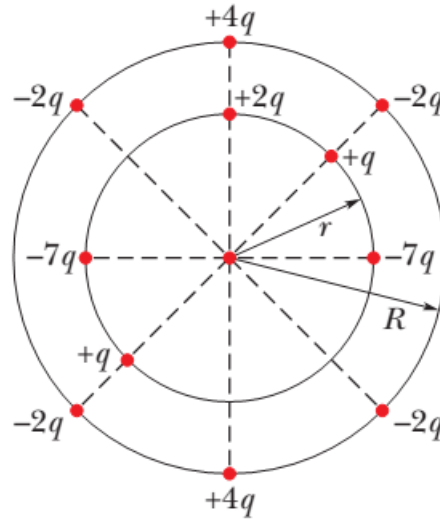
In the figure below, a central particle of charge $-q$ is surrounded by two circular rings of charged particles. What are the magnitude and direction of the net electrostatic force on the central particle due to the other particles ?

a) 0

b) $k_e \frac{-2q^2}{r^2}$, up

c) $k_e \frac{2q^2}{r^2}$, up

d) $k_e \frac{-2q^2}{r^2}$, left

e) $k_e \frac{2q^2}{r^2}$, right

Problem 2

The figure below shows three situations in which four charged particles are evenly spaced to the left and right of a central point. The charge values are indicated. Rank the situations according to the magnitude of the net electric field at the central point, greatest first.

(1) ●————●————●————●————●
    +e   −e   −e   +e

(2) ●————●————●————●————●
    +e   +e   −e   −e

(3) ●————●————●————●————●
    −e   +e   +e   +e

a) 0
b) 1, 2, 3
c) 2, 3, 1
d) 1, 3, 2
e) 3, 1, 2

Problem 3

The figure below shows straight nonconducting rod. It has positive charge $+Q$ uniformly distributed along its top half and negative charge $-Q$ uniformly distributed along its bottom half. What is the direction of the net electric field at point P?
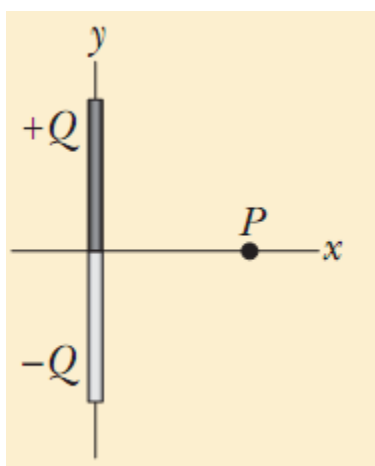

a) Up
b) Down
c) Left
d) Right
e) Cannot be determined

Problem 4

Two small beads having positive charges $+3q$ and $+q$ are fixed at the opposite ends of a horizontal rod of length $d = 1.5\ m$, located along the positive x-direction. The bead with charge $+3q$ is at the origin. If a third small charged bead is free to slide on the rod. At what position x is the third bead in equilibrium.

a) 0.853m
b) 0.350m
c) 0.951m
d) 1.250m
e) 0.103m
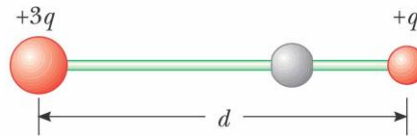
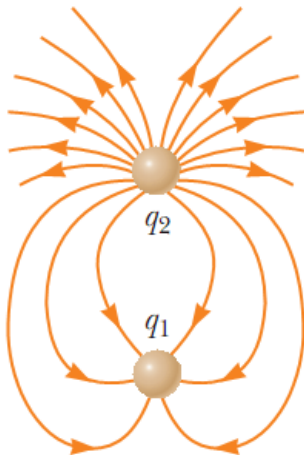## Problem 5

A continuous line of charge lies along the x-axis, extending from $x = +x_0$ to positive infinity. The line carries positive charge with a uniform linear charge density λ_0. What is the magnitude of the electric field at the origin?

a) $k_e\ \lambda_0/x_0$
b) $2k_e\ \lambda_0/x_0$
c) $k_e\ \lambda_0/x_0{}^2$
d) $k_e\ \lambda_0 ln(x_0)$
e) $k_e\ \lambda_0/6x_0$

Problem 6

The figure shows the electric field lines for two charged particles separated by a small distance. Determine the ratio q_1/q_2 including the signs of the charges.

a) 1/3
b) -2/3
c) 3
d) -1/3
e) Not sufficient information to decide

Problem 7

The figure below shows a charged rod in the shape of a semicircle. The linear charge density is given as $\lambda = a \sin(\theta)$, where a is a positive constant, and the angle θ is measured from the +ve x-axis as shown in the figure.
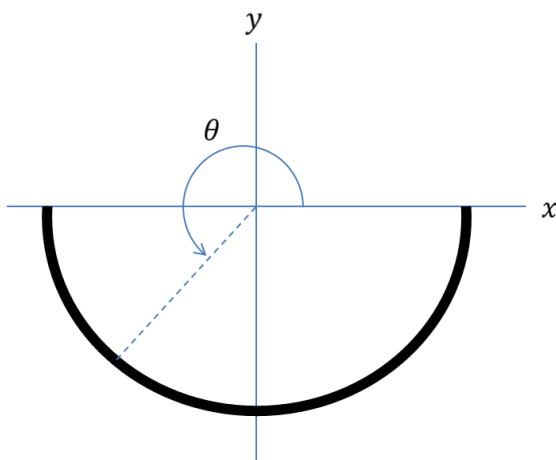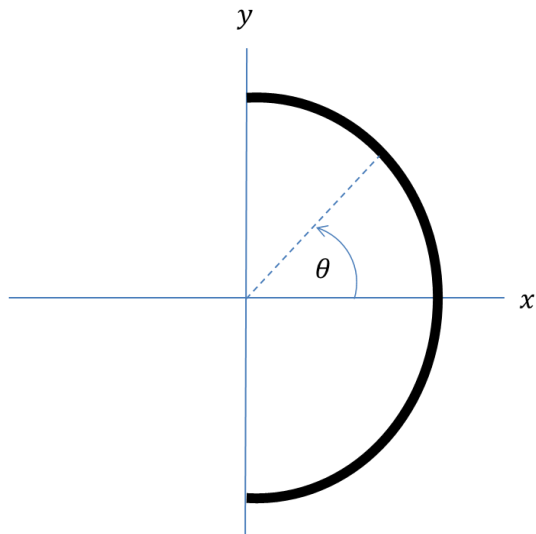

Find the total charge of the rod.

a) $+2aR$
b) 0
c) $-2aR$
d) $+aR$
e) $-aR$

Problem 8

The figure below shows a charged rod in the shape of a semicircle. The linear charge density is given as $\lambda = a \sin(\theta)$, where a is a positive constant, and the angle θ is measured from the +ve x-axis as shown in the figure.


The electric field at the origin has the following features

a) E_x is $-ve$, E_y is zero
b) E_x is zero, E_y is $-ve$
c) E_x is zero, E_y is $+ve$
d) E_x is $+ve$, E_y is zero
e) E_x is $-ve$, E_y is $-ve$

Problem 9

Figure (a) shows three parallel, plastic, infinite, uniformly charged sheets. Figure (b) shows the x-component of the net electric field for each region of space separated by the sheets. The scale of the vertical axis is $E_s = 6.0 \times 10^5 \ N/C$. What is the surface charge density on sheet 1?

a) $\sigma_1 = 1.77 \ \mu \ C/m^2$
b) $\sigma_1 = 7.07 \ \mu \ C/m^2$
c) $\sigma_1 = 3.53 \ \mu \ C/m^2$
d) $\sigma_1 = 10.61 \ \mu \ C/m^2$
e) not enough information
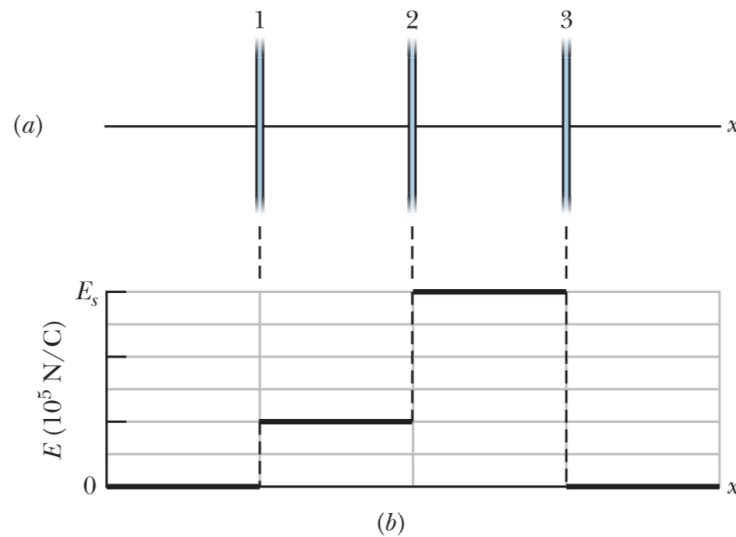
Problem 10

Rank in order, from largest to smallest, the magnitude of the electric fields E_1 to E_4 in the following figure.
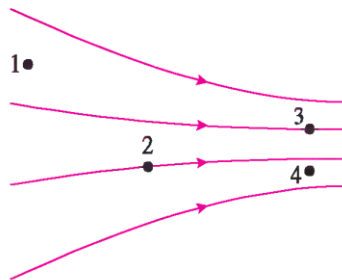
a) 1, 2, 3=4
b) 3=4, 2, 1
c) 1, 2, 3, 4
d) 4, 3, 1=2
e) 1=2, 3, 4

Problem 11

In the figure below, an electron travels through a small hole in plate A and then toward plate B. A uniform electric field in the region between the plates then slows the electron without deflecting it. What is the direction of the field between the plates?

A   B
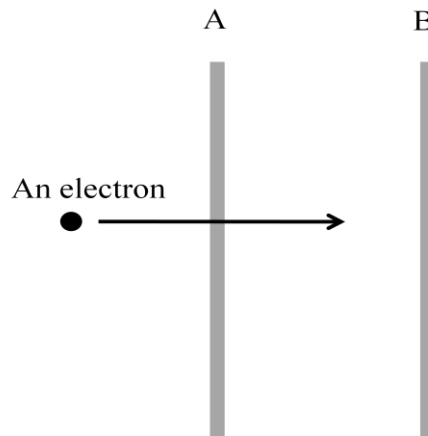
An electron

a) To the left
b) To the right
c) Up
d) Down
e) Cannot be determined

Problem 12

The total electric flux through the box shown in figure is

$\vec{E} = (1\ \text{N/C, up})$

Plane of charge

$\vec{E} = (1\ \text{N/C, down})$

Cross section of a
1 m × 1 m × 1 m box
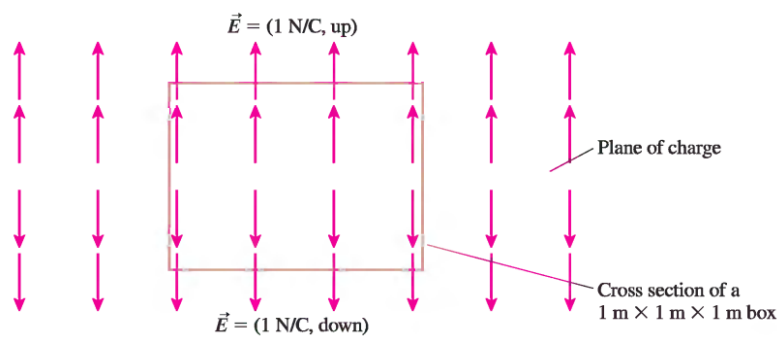
a) $0\ \text{Nm}^2/\text{C}$
b) $1\ \text{Nm}^2/\text{C}$
c) $2\ \text{Nm}^2/\text{C}$
d) $4\ \text{Nm}^2/\text{C}$
e) $6\ \text{Nm}^2/\text{C}$

Problem 13
High speed protons ($q_p = 1.6 \times 10^{-19}C$) are accelerated through an electric field of 2.00×10^4 N/C. What speed would the proton attain if the field accelerated the proton, from rest, through a distance of 1.00 cm?

a) 3.28×10^5 m/s
b) 1.66×10^6 m/s
c) 8.25×10^5 m/s
d) 3.32×10^7 m/s
e) 1.96×10^5 m/s

Problem 14
A closed surface with dimensions $a = b = 0.40\ m$, and $c = 0.60\ m$ is located as shown in the figure. If the electric field is non-uniform and given by: $\vec{E} = (3.00 + 2.00\ x^2)\ \hat{\imath}$ N/C, where x is in meters. The net electric flux leaving the closed surface is:

a) 3.253 N.m²/C
b) 0.269 N.m²/C
c) 1.654 N.m²/C
d) 0.085 N.m²/C
e) 9.652 N.m²/C
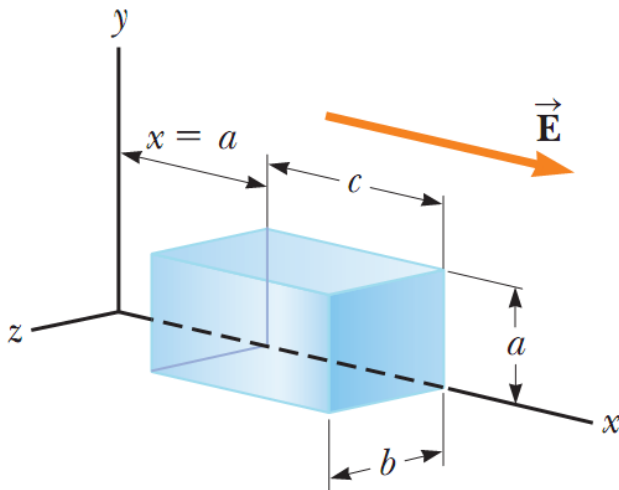
Problem 15

A particle with charge $Q = 5.00\ \mu C$ is located at the center of the shown cube of edge $L = 0.100m$. In addition, six other identical charged particles having $q = -1.00\ \mu C$ are positioned symmetrically around Q as shown. Determine the electric flux through one face of the cube.

a) +37.2 kN.m²/C
b) -18.8 kN.m²/C
c) -9.4 kN.m²/C
d) -45.6 kN.m²/C
e) +5.00 kN.m²/C
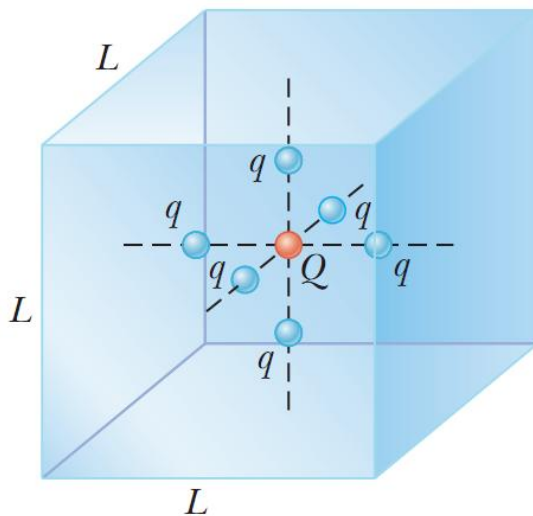
Problem 16

The figure below shows a line of charge with constant linear charge density λ. The line extends from $x = 0$ to $x = L$ along the x-axis.
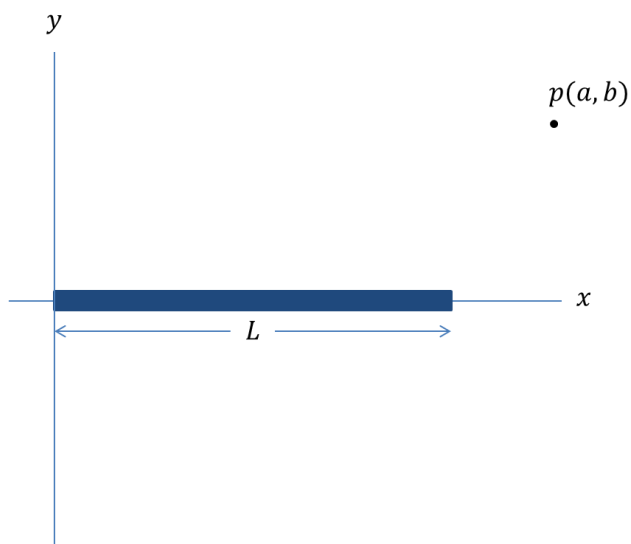
The x-component of the electric field at point p, which has coordinates (a, b) is given by

a) $\int_0^L \dfrac{k_e \, \lambda \, b \, dx}{[(a-x)^2+b^2]^{3/2}}$

b) $\int_0^L \dfrac{k_e \, \lambda \, dx}{[(a-x)^2+b^2]}$

c) $\int_0^L \dfrac{k_e \, \lambda \, dx}{[x^2+b^2]}$

d) $\int_0^L \dfrac{k_e \, \lambda \, (a-x) \, dx}{[(a-x)^2+b^2]^{3/2}}$

e) $\int_0^L \dfrac{k_e \, \lambda \, (a-x) \, dx}{[x^2+b^2]^{3/2}}$

Problem 17

The left figure below shows a solid insulating sphere of radius a with uniform charge distribution throughout its volume. The total charge on the sphere is Q_1. A spherical shell of radius b is concentric with the inner sphere and has a total charge of Q_2. The right figure below shows a plot of the total electric flux through a sphere of radius r.
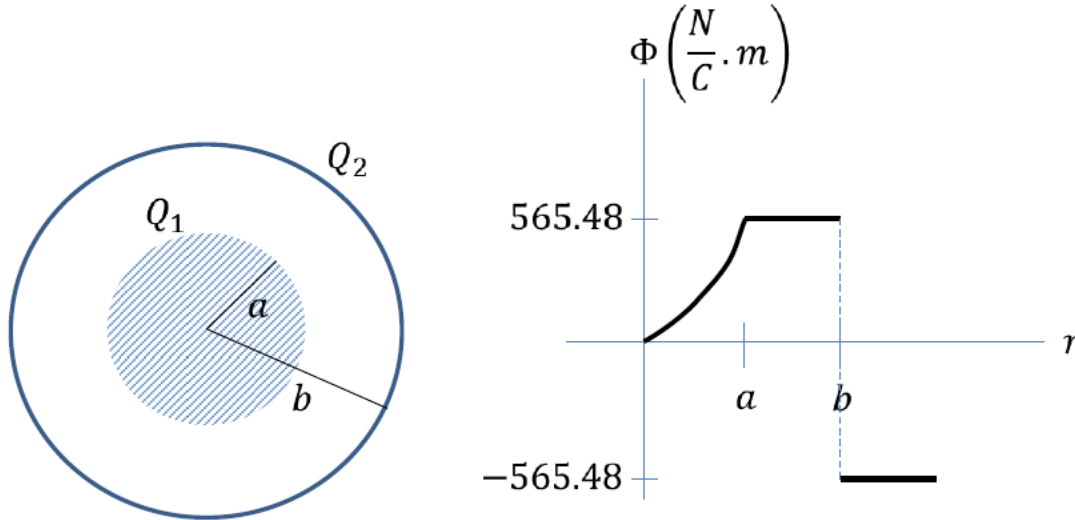
The values of Q_1 and Q_2 are:

a) $Q_1 = -5nC$, $Q_2 = +10nC$
b) $Q_1 = -10nC$, $Q_2 = +5nC$
c) $Q_1 = +5nC$, $Q_2 = -5nC$
d) $Q_1 = +5nC$, $Q_2 = -15nC$
e) $Q_1 = +5nC$, $Q_2 = -10nC$

Problem 18

A flat area in the shape of a square of side length b is located in the x-y plane. An electric field exists in space given by $\vec{E} = 3\hat{\imath} + 2\hat{\jmath} - 5\hat{k}$. The magnitude of the electric flux though the surface area is equal to

a) 0
b) $2 b^2$
c) $5 b^2$
d) $10 b^2$
e) $3 b^2$

Problem 19
An electron is released 9.0 cm from a very long nonconducting rod with a uniform 6.0 μC/m. What is the magnitude of the electron's initial acceleration?

a) $0.15 \times 10^{17} \text{m/s}^2$
b) $0.30 \times 10^{17} \text{m/s}^2$
c) $0.15 \times 10^{15} \text{m/s}^2$
d) $0.30 \times 10^{15} \text{m/s}^2$
e) $2.1 \times 10^{17} \text{m/s}^2$

Problem 20
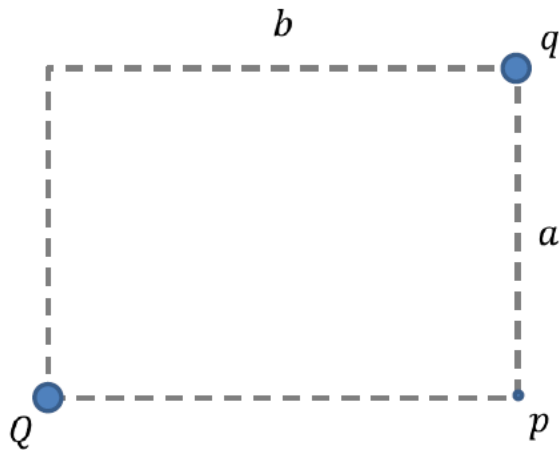The figure below shows a section of a very long, thin-walled metal tube of radius $R = 3.00 \ cm$, with a charge per unit length of $\lambda = 2.00 \times 10^{-8} C/m$. What is the magnitude of the electric field at radial distance $r = 2R$?
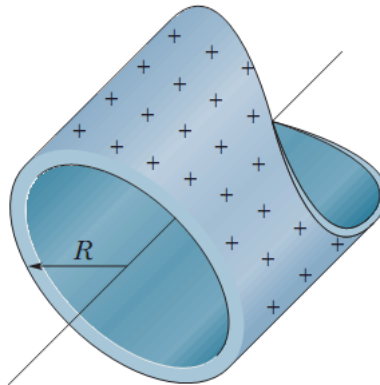
a) $0.07 \times 10^3 N/C$
b) $0.14 \times 10^3 N/C$
c) $6.2 \times 10^5 N/C$
d) $6 \times 10^3 N/C$
e) $60 \times 10^3 N/C$

Problem 21

Two charges, q and Q, are located at opposite corners of a rectangular shape as shown in the figure.

Given that $a = 40\ cm$, $b = 70\ cm$, $Q = -2nC$, $q = 3nC$. What is the magnitude of the electric field at point p located at the bottom right corner of the rectangle?

a) 172.7 N/C
b) 36.73 N/C
c) 168.75 N/C
d) 72.23 N/C
e) 45.27 N/C

Problem 22

A particle (mass = 4.0 g, charge = 80 mC) moves in a region of space where the electric field is uniform and is given by $E_x = -2.5$ N/C, $E_y = E_z = 0$. If the velocity of the particle at $t = 0$ is given by $v_x = 80$ m/s, $v_y = v_z = 0$, what is the speed of the particle at $t = 2.0$ s?

a) 40 m/s
b) 20 m/s
c) 60 m/s
d) 80 m/s
e) 180 m/s

Problem 23

A line of positive charge is formed into a semicircle of radius $R = 60.0\ cm$. The charge per unit length along the semicircle semicircle is given by: $\lambda = \lambda_0 \cos\theta$; the total charge on the semicircle is $12.0\ \mu C$. Calculate the total force on a charge of $3.00\ \mu C$ placed at the center of curvature.
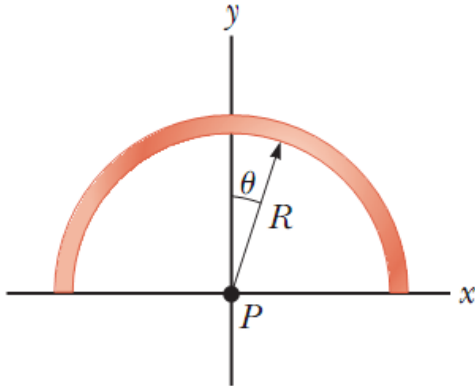
a) $2.016\ \hat{\imath}$ N
b) $3\ \hat{\imath} + 4\hat{\jmath}$ N
c) $-0.706\ \hat{\jmath}$ N
d) $-12\ \hat{\imath}$ N
e) $0.866\ \hat{\jmath}$ N

Problem 24

A solid sphere of radius $40.0\ cm$ has a total positive charge of $26.0\ \mu C$ uniformly distributed throughout its volume. The magnitude of the electric field $60.0\ cm$ from the center of the sphere is:

a) 3.25×10^5 N/C
b) 1.30×10^6 N/C
c) 5.43×10^5 N/C
d) 4.34×10^5 N/C
e) 6.49×10^5 N/C

Problem 25

Consider the following two separate cases:
Case A: A solid sphere, good conductor, of radius 5 cm and total charge of $2\ \mu C$.
Case B: A solid sphere, insulator, of radius 5 cm and total charge of $2\ \mu C$ which is uniformly distributed throughout its volume.
How do the magnitudes of the electric fields they separately create at a distance 6 cm from the center compare?

a) $E_A > E_B = 0$
b) $E_A > E_B > 0$
c) $E_A = E_B > 0$
d) $0 < E_A < E_B$
e) $0 = E_A < E_B$

Problem 26

Two identical conducting spheres each having a radius 0.500 cm are connected by a light, 2.00-m-long conducting wire. A charge of 60.0 μC is placed on one of the conductors. Assume the surface distribution of charge on each sphere is uniform. In electrostatic equilibrium, determine the tension in the wire.

a) 2.0 N
b) 8.1 N
c) 3.4 N
d) 5.1 N
e) 7.5 N

Problem 27

A uniform linear charge density of 4.0 nC/m is distributed along the entire x axis. Consider a spherical (radius = 5.0 cm) surface centered on the origin. Determine the electric flux through this surface.

a) 68 N m^2/C
b) 62 N m^2/C
c) 45 N m^2/C
d) 79 N m^2/C
e) 23 N m^2/C

Problem 28

Charge of uniform linear density (4.0 nC/m) is distributed along the entire x axis. Determine the magnitude of the electric field on the y axis at $y = 2.5$ m.

a) 36 N/C
b) 29 N/C
c) 43 N/C
d) 50 N/C
e) 58 N/C

Problem 29

A small non conducting ball of mass $m = 1.0 \times 10^{-3}$g and charge $q = 2 \times 10^{-8}C$ hangs from an insulated thread that makes an angle $\theta = 30^0$ with a large vertical uniformly charged non-conducting sheet carrying a charge per unit area σ C/m^2. Considering all forces on the ball, including the gravitational force, find σ that would keep the ball in equilibrium at 30^0.

a) 4.25.00 nC/m^2
b) 8.75 nC/m^2
c) 3.00 nC/m^2
d) 5.00 nC/m^2
e) 6.50 nC/m^2

Problem 30

A solid insulating sphere is concentric with conducting spherical shell where $a = 5.00\ cm$, $b = 20.0\ cm$ and $c = 25.0\ cm$. The charge on the insulating sphere is negative and equal to $(- 4.01$ nC). If the electric field at a point $50.0\ cm$ from the center is of magnitude 200 N/C and points radially outward, find the net charge on the conducting spherical shell.
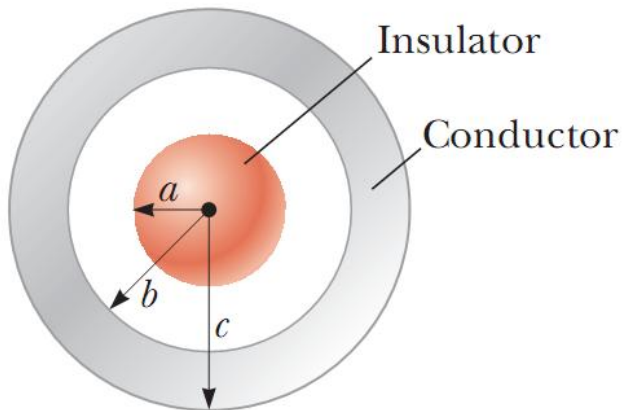
a) 9.57 nC
b) 6.34 nC
c) 3.76 nC
d) 1.25 nC
e) 7.50 nC

Problem #	Answer
1	C
2	C
3	B
4	C
5	A
6	D
7	C
8	B
9	A
10	B
11	B
12	C
13	E
14	B
15	B
16	D
17	E
18	C
19	E
20	D
21	A
22	B
23	C
24	E
25	C
26	A
27	C
28	B
29	D
30	A